

### AMENDMENTS TO THE CLAIMS

Please amend Claims 1, 3-5, 7-12, 15, 16, 18 and 20-23 as indicated below.

Please add new Claims 27 and 28 as indicated below.

1. (Currently amended) An optical receiver module comprising:  
a photodiode chip, ~~wherein~~ with a PIN photodiode is formed on a front side of the ~~photodiode chip~~ a semiconductor wafer and electrical contacts to the PIN photodiode are formed on a backside of the ~~photodiode chip~~ semiconductor wafer; and  
a transimpedance amplifier chip with electrical terminals coupled to the backside of the photodiode chip by solder bumps to form a chip-on-chip module.
2. (Original). The apparatus of Claim 1, wherein the PIN photodiode is fabricated using InP, and an InGaAs layer is formed on a P+ layer for making an ohmic contact.
3. (Currently amended) The apparatus of Claim 1, wherein vias couple the electrical contacts on the backside of the ~~photodiode chip~~ semiconductor wafer to a cathode and an anode of the PIN photodiode on the front side of the ~~photodiode chip~~ semiconductor wafer.
4. (Currently amended) An apparatus comprising:  
an optoelectronic device formed on a front side of ~~an optoelectronic chip~~ a semiconductor wafer in an integrated circuit fabrication process; and  
at least one electrical contact on a backside of the ~~optoelectronic chip~~ semiconductor wafer, wherein the electrical contact is electrically coupled to the optoelectronic device through a ~~substrate of the optoelectronic chip~~ via in the semiconductor wafer.
5. (Currently amended) The apparatus of Claim 4, wherein the optoelectronic ~~chip~~ device interfaces an optical system with an electrical system, and the front side of the ~~optoelectronic chip~~ semiconductor wafer is proximal to the optical system.
6. (Original) The apparatus of Claim 4, wherein the optoelectronic device has an aperture for communication with an optical system, and the aperture is proximal to the optical system.
7. (Currently amended) The apparatus of Claim 5, wherein the backside of the ~~optoelectronic chip~~ semiconductor wafer is proximal to the electrical system.

8. (Currently amended) The apparatus of Claim 4, further comprising a chip carrier, and wherein the backside of the ~~optoelectronic chip~~ semiconductor wafer is mounted on the chip carrier to assemble a chip package.

9. (Currently amended) The apparatus of Claim 4, further comprising an electronic chip, and wherein the backside of the ~~optoelectronic chip~~ semiconductor wafer is mounted on the electronic chip to assemble a chip-on-chip module.

10. (Currently amended) The apparatus of Claim 8, wherein the electrical contact on the backside of the ~~optoelectronic chip~~ semiconductor wafer is electrically connected to an electrical contact on the chip carrier using a solder bump.

11. (Currently amended) The apparatus of Claim 9, wherein the electrical contact on the back side of the ~~optoelectronic chip~~ semiconductor wafer is electrically connected to an electrical contact on the electronic chip using a solder bump.

12. (Currently amended) An apparatus comprising:

an array of optoelectronic devices formed on a front side of a ~~chip~~ semiconductor wafer; and

a corresponding array of electrical contacts on a backside of the ~~chip~~ semiconductor wafer, wherein the electrical contacts are electrically coupled to the corresponding optoelectronic devices by respective vias through ~~a substrate of the chip~~ the semiconductor wafer.

13. (Original) The apparatus of Claim 12, wherein the optoelectronic devices are photo detectors.

14. (Original) The apparatus of Claim 12, wherein the optoelectronic devices are light emitting devices.

15. (Currently amended) An apparatus for sensing a light signal and for producing a corresponding electrical signal, the apparatus comprising:

a photodiode formed on a front side of a semiconductor ~~chip~~ wafer in fabrication of an integrated circuit;

a first contact on a back side of the semiconductor ~~chip~~ wafer, wherein the first contact is electrically coupled to an anode of the photodiode by a first via through a ~~substrate of the semiconductor chip~~ wafer; and

a second contact on the back side of the semiconductor ~~chip~~ wafer, wherein the second contact is electrically coupled to a cathode of the photodiode by a second via through ~~the substrate of the semiconductor chip~~ wafer.

16. (Currently amended) The apparatus of Claim 15, wherein the semiconductor ~~chip~~ wafer is ~~fabricated in a Si, Ge, GaAs, or InP semiconductor system material.~~

17. (Original) The apparatus of Claim 15, wherein the photodiode is a PIN photodiode, an avalanche photodiode, or a metal-semiconductor-metal Schottky photodiode.

18. (Currently amended) The apparatus of Claim 15, wherein the photodiode is used in an optical communication system to interface a fiber optic cable with an electronic receiver circuit, the front side of the semiconductor ~~chip~~ wafer is proximal to an output of the fiber optic cable for receiving the light signal, and the backside of the semiconductor ~~chip~~ wafer is proximal to an input of the electronic receiver circuit for providing the corresponding electrical signal.

19. (Original) The apparatus of Claim 15, further comprising a chip carrier, and wherein the first contact and the second contact are electrically bumped to corresponding contacts on the chip carrier.

20. (Currently amended) The apparatus of Claim 15, further comprising an electronic receiver chip, wherein the backside of the semiconductor ~~chip~~ wafer is coupled to a front side of the electronic receiver chip to form a chip-on-chip stack, and wherein the photo detector is exposed on top of the chip-on-chip stack for receiving the light signal.

21. (Currently amended) The apparatus of Claim 20, wherein the first contact and the second contact on the backside of the semiconductor ~~chip~~ wafer are electrically bumped to corresponding contacts on the front side of the electronic receiver chip.

22. (Currently amended) The apparatus of Claim 20, wherein the electronic receiver chip is a transimpedance amplifier, and the anode and the cathode of the photodiode are coupled to respective inputs of the transimpedance amplifier by bumping the backside of the semiconductor ~~chip~~ wafer to the front side of the electronic receiver chip.

23. (Currently amended) An apparatus for receiving an electrical signal and for producing a corresponding light signal, the apparatus comprising:

a laser diode formed on a front side of a ~~chip-substrate~~ semiconductor wafer; and

Appl. No. : 10/669,081  
Filed : September 23, 2003

contacts formed on a backside of the ~~chip-substrate~~ semiconductor wafer, wherein the contacts are electrically coupled to the laser diode by electrically conductive via holes through the ~~chip-substrate~~ semiconductor wafer.

24. (Original) The apparatus of Claim 23, wherein the laser diode is a distributed-feedback laser or a vertical surface emitting laser.

25. (Canceled).

26. (Canceled).

27. (New) The optical receiver module of Claim 1, wherein the PIN photodiode is formed by epitaxial layers grown on the semiconductor wafer.

28. (New) The apparatus of Claim 4, wherein the optoelectronic device is formed by epitaxial growth on the semiconductor wafer.